Rethinking IS Curricula for South Africa

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Abstract: What to teach students in an undergraduate program in Information Systems at a tertiary institution has repeatedly been debated over the years. Various curricula have been published, the most recent effort being the IS '95 Curriculum currently being discussed. Very often such curricula, or at least the particular implementation at a particular institution, is the product of the idiosyncratic preferences of (certain) academics. While it is recognized that academics have a duty to maintain a longer term view and would therefore often have 'academic reasons' for including certain material or approaches in a curriculum, it is indefensible that an IS curriculum should be developed and deployed without a considerable input from the eventual employers of IS graduates. This can also not be a once-off exercise, but must, in view of the ever changing requirements of the information systems environment, be part of a learning process in which the institution improves its teaching program. This paper presents an analysis of the skills required by businesses in South Africa from entry-level programmers, systems analysts and end-user support personnel and discusses the implications these needs have for an academic IS Department.

Keywords: IS Curriculum; IS Skills Requirements, IS Training and Development

Computing Review Category: K.3.2

1. Introduction

To ensure that their students are qualified to meet the demand of the labour market, tertiary institutions should modify their curricula from time to time - especially in view of the high unemployment rate experienced by many countries.

Another factor necessitating change to Information Systems (IS) curricula, is the fast changing IS environment. To complicate matters, information technology (IT) is developing at an even faster pace. Aside from changing needs, completely new needs evolve.

An IS curriculum should differ decidedly from a computer science curriculum in terms of the milieu in which the program is taught, the employment environment for the graduate, and the depth of technical expertise required. The IS curriculum should teach information system concepts and processes within two contexts, organizational functions and management knowledge, as well as technical information system knowledge, whereas computer science tends to be taught within an environment of mathematics, algorithms, and in some cases, engineering technology.

The first attempt at a non-computer science curriculum was made in 1972 by the ACM Curriculum Committee on Computer Education for Management when it first presented its recommendations for graduate professional programs in IS [3]. Revised curriculum recommendations of undergraduate and graduate programs were presented in 1982, considering the importance of information systems, advances in technology, improvement in IS analysis and development processes, and an increased need for IS management skills [11].

This report states (*op. cit.*) that labour economics and skill requirements in the private and public sectors have resulted in increasing demand for more information systems and broader application of the IS technology. Businesses are also becoming more interested in the possible IS solutions to business problems, well exceeding the capabilities of the IS community to satisfy these demands. In addition to the increase in the total number of systems in use, a growth in average complexity compounds this problem.

The most recent work on the proposed IS curriculum, undertaken by the Joint Task Force of ACM, AIS and DPMA [6], presented the IS'95 Body of Knowledge shown in Table 1.

BODY OF INFORMATION SYSTEMS KNOWLEDGE		
1.0	Information Technology	
	1.1	Computer Architectures
	1.2	Algorithms and Data Structures
	1.3	Programming Languages
	1.4	Operating Systems
	1.5	Telecommunications
	1.6	Database
	1.7	Artificial Intelligence
2.0	Organizational and Management Concepts	
	2.1	General Organizational Theory
	2.2	Information Systems Management
	2.3	Decision Theory
	2.4	Organizational Behaviour
	2.5	Managing the process of change
	2.6	Legal and Ethical aspects of IS
	2.7	Professionalism
	2.8	Interpersonal Skills
3.0	Theory and Development of Systems	
	3.1	Systems and Information Concepts
	3.2	Approaches to Systems Development
	3.3	Systems Development Concepts and Methodologies
	3.4	Systems Development Tools and Techniques
	3.5	Application Planning
	3.6	Risk Management
	3.7	Project Management
	3.8	Information and Business Analysis
	3.9	Information Systems Design
	3.10	Systems Implementation and Testing Strategies
	3.11	Systems Operation and Maintenance
	3.12	Systems Development for Specific Types of Information Systems

Table 1

The above body of knowledge and the accompanying curriculum details are aimed more at satisfying Northern Hemisphere requirements. It cannot be assumed, unfortunately, that this proposal would necessarily satisfy South African needs. The framework could, however, be used as a guideline.

In order to design an IS curriculum for South African conditions, this study approached businesses in South Africa to determine their expectations of IS graduates.

The process of curriculum planning or design should be a structured and disciplined activity [8]. The diagram below in Figure 1 gives a generic framework for curriculum planning and improvement. A structured approach to apply the framework is presented in [8], where it is shown how, during a multi-phased project, a curriculum can be re-evaluated and changed. In phase C of such a project alumni and employer surveys are conducted along with external assessments through, e.g., self-evaluation against external standards, such as IS'95. An analysis of an external standard such as IS'95 is presented in [9]. The results of alumni and employer surveys, also part of phase C, are presented in full detail in [7], with excerpts discussed below.

Note that this framework focuses on curriculum content and the achievement of objectives, but excludes lecturer performance. It is based on the concept of double loop learning proposed by Argyris [2]. In single loop learning, program and course adjustments are merely made based on the results of measuring student performance. Though the content of courses remains unchanged, the levels at which they are presented are adjusted.

Double loop learning, on the other hand, questions the assumptions and norms on which the curriculum is based. This process uses alumni and employer survey information and/or external assessment information.

A Generic Framework for Curriculum Planning and Improvement

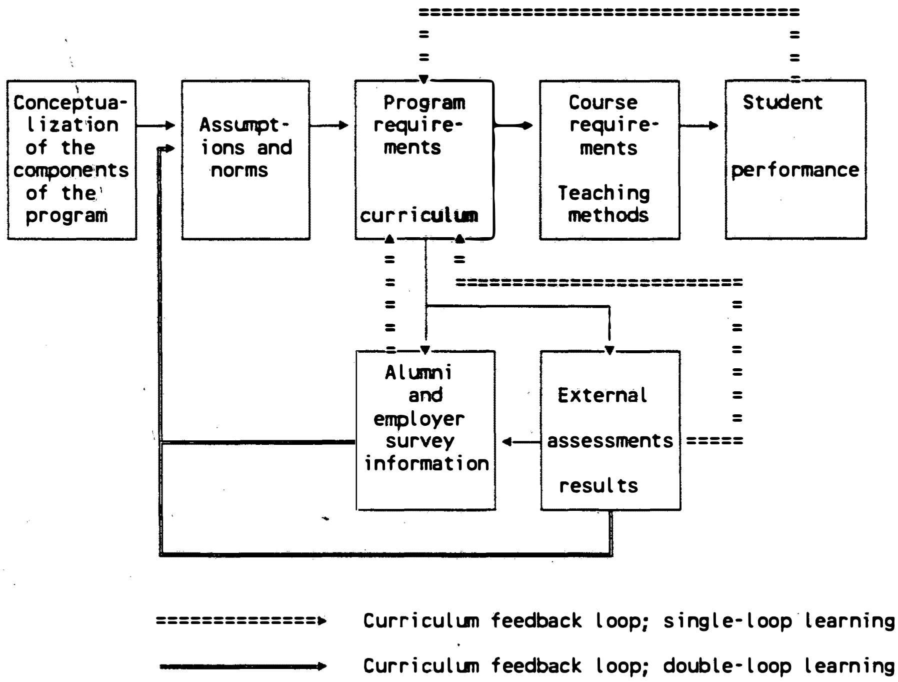

Figure 1

The framework shows that alumni and employer survey information and external assessment results could also be part of a single loop learning process, in which the program requirements and curriculum are reviewed.

Alumni and employer surveys were undertaken during the second half of 1994 as part of a curriculum review process within the context described above. Only the results of the employer survey are discussed in this paper.

2. Critique of previous research

Many previous studies are methodologically strong and make useful additions to the literature concerning the requisite skills of IS graduates depending on the positions they intend to fill. However, some of these studies suffered from certain deficiencies.

Insufficient explanation of study procedures
A number of studies did not include all of the basic information pertaining to the study. Some of the basic information that was lacking included the source and nature of the sample, how it was drawn, the sample size, return rates for surveys, etc.

Inadequate and unclear measures
Most of the research papers did not adequately describe the measures used, thus making evaluation of the research done, difficult. The reliability and/or validity of research could therefore not always be assessed.

Inadequate sample sizes and statistical techniques
The appropriate statistical techniques were not always used (for instance Zawacki *et al.* [19] and Cheney and Lyons [5]), while other studies used incorrect statistical techniques to analyze their data. In a few cases the sample sizes were too small for the types of statistical analyses being attempted. These results were often presented as the perceptions of the industry, while no statistical ground for such assumptions existed. Some of the surveys, though of appropriate sample size, were taken in a central geographical location or in a certain section of an industry - eg, while Nelson *et al.* [14] certainly met all requirements of adequate sample size, appropriate statistical techniques and explanation of study procedures, the survey was restricted to organizations with a revenue of $100 million a year and more than 1000 employees, with the assumption that the view of the larger or more mature organizations represented the entire industry. These results were then presented as the viewpoint of an entire country or industry.

Indefensible conclusions
It was surprising to find discussions and conclusions that went far beyond what the data would prudently allow. Indefensible interpretations were sometimes made of the results of statistical analyses. This might be due to inadequate experience in interpreting statistical results.

Problematic study design
More effort or thought during the study design phase of the research could have rendered some of the research far more valuable, for example, the work of Watson *et al.* [18] and Albin and Otto [1]. The general form of statistical analysis used, were surveys asking respondents to rank a list of skills. This type of statistical analysis can be very useful, but lacks the depth to determine the skill requirements of IS graduates.

Although it is necessary to know which skills are required of IS graduates, it is not very helpful if it is not known at what level these skills are required. IS curricula are set up to provide the IS graduate with various skills at varying ability levels. Skills that are ranked first or most important are not necessarily required at a proficient level, yet this is precisely what some authors imply.

3. Research methodology

The main purpose of this study was to determine the skills and competencies employers (IS managers) require of IS graduates in South Africa. These requirements could be used to evaluate present curricula in order to point out any deficiencies if they exist. The study also intended to assert whether or not the skill requirements of the different types of IS personnel differ and the implications this might have for curriculum design.

Questionnaires were posted to the IS managers of 240 organizations with IS divisions. These organizations, differing in size and succsessfulness, are distributed all over South Africa, some as far as Namibia. This was done so the response would reflect the perceptions of the whole IS industry in South Africa, and not as in other studies only the perceptions of the largest organizations. IS graduates are employed by any organization, irrespective of its size. The needs of IS departments are expected to differ, depending on their size, thus we wanted all opinions expressed to determine the overall requisite skills needed by IS graduates.

A total of 73 questionnaires were returned by IS managers, yielding a response rate of 30%. Unanswered questions or suspect data were verified by phone.

Determining the skills required of IS graduates is not very useful, if it is not clearly understood what is meant by the words 'skill' and 'competency'. The origin and concept of the skills and competencies used in the questionnaire are discussed below.

Goldsworthy [10] defined skills as referring to a person's ability to do something well. It relates to expertness, a practical ability, and a dexterity in performing a task. It is an outcome that flows from knowledge, practice, inherent abilities and an understanding of the task to be performed. He further states that competency amounts to a demonstration of an individual's competence through performance in the workplace. Competency is based on a skill being applied in the workplace.

A skill is thus a form of knowledge that can be acquired at various levels of ability. A graduate possesses a certain competency, if that person possesses a skill at a sufficient level of ability to apply it in the workplace. A competency is thus distinctly required at a higher level of ability than a skill.

For the purpose of this study, the notion of 'competency' is defined as including skill, but representing a wider concept that includes the so called 'soft' skills, such as management skills and human relations. Most of the competencies and skills evaluated in this study were first put forward by Watson *et al.* [18], though they did not distinguish between competencies and skills, nor did they measure various levels of ability. Additional skills stem from the literature reviewed, as well as one or two additions made for the purposes of the research. The full list of skills and competencies used in the questionnaire, is given below in Table 2. The list was open-ended allowing for additional skills to be added by the respondents, but no significant additions were made.

The various levels of ability required are taken from work done by Jenkins [12] and are defined as follows:

* Proficient: Performs task without supervision
* Knowledgeable: Has knowledge, but needs supervision
* Familiar: Understands the concept, but needs close supervision and more training.

4. Analysis methods

A number of analysis methods were used and the application of these will be briefly discussed below. The results obtained from these methods are given in the Appendix.

The mean and standard deviations were calculated for the responding industries and regions, referring to the number of employees in IS Departments and the number of graduates employed per year. Various frequency distributions were obtained regarding the industries that responded, the geographical location of these industries, the number of employees in their IT/MIS divisions, the number of university graduates employed per year and whether they were in need of further training.

An attempt was made to find a linear fit between the size of an IT/MIS division and the number of graduates employed per year. The assumption was made that the greater the size of the IT/MIS division, the greater the number of graduates employed per year. However, this relationship could not be proved. In fact, no relationship at all was to be found.

This indicates a number of inter-related factors, influencing the employment rate of graduates, that differ from organization to organization. To determine these factors would require further research. Two possible factors influencing the employment rate of graduates could be the maturity of the IT/MIS division and the turnover rate of personnel.

Analysis of variance was used to determine whether or not the type of personnel has any effect on the requirements of businesses. In addition, Scheffé's procedure of comparison in pairs was used to determine whether the mean of the weighted requirements differs significantly at a 5% level of significance. This showed that a higher mean level of ability is required of systems analysts.

Goodman [16] presented the log-linear analysis technique, also known as contingency analysis, in 1970. This technique can be used for the detail analysis of the interaction structure between the factors in a observed two, three or multiway contingency table. A contingency table is a summary of a one or multi variable data set presented in the form of a one or multiway frequency distribution.

COMPETENCIES AND SKILLS EVALUATED IN THIS STUDY
COMPETENCIES
Business communication and interpersonal skills (interviewing)
Information systems planning
Management skills
Peopleware (Human factors in information systems)
Systems approach
Concepts of computer security
Legal aspects of Computing
SKILLS
Application programming languages (COBOL, PASCAL, ...)
Systems analysis and design
Problem solving
Data base concepts/ Data structures
Operating Systems
Business knowledge and skills (Accounting, Marketing)
Documentation skills
Fourth generation languages
Mainframe experience
Packages (Spreadsheet, Wordprocessing, Graphics)
Telecommunications and networking
System implementation
CASE methodologies
Modelling (Math, Statistics)
Decision Support Systems / Executive Information Systems
Expert Systems/ Artificial Intelligence
Writing skills (reports , etc.)
Presentation techniques
CASE tools

Table 2

This technique was used to analyze the different types of IT personnel with regard to the skills and competencies required of entry level employees by the responding businesses. This is done in two phases. Firstly one has to determine whether the independent or saturated model is applicable, using the following statistic:

$$L = 2\Sigma^{I}_{i=1}\Sigma^{J}_{j=1} W_{ij} \ln(W_{ij} / V_{ij}) \quad \sim \chi^2_{(I-1)(J-1);\ \alpha} \text{ distributed}$$

$$\sim \chi^2_{(50);\ \alpha} \quad (\alpha = 0{,}05) \text{ with } I = 3 \text{ and } J = 26$$

Throughout the use of this technique the saturated model was applicable at a 5% level of significance. Secondly, the meaningfulness of each of the effects measured at a 1% level of significance was established.

5. Results

Cheney, Hale and Kasper [4] proposed that legal aspects of computing are gaining importance. This study found that legal aspects of computing are significantly more required at a familiar level by all three job categories, thus supporting the findings of Watson *et al.* [18]. The results of this study might have been influenced by the organizational maturity of the IS function, or these skills might only be required of higher level positions.

This study support the findings of other studies that IS curricula are too technically oriented. Businessmen and IS managers are placing more emphasis on general and managerial skills, with communication skills cited by all studies to be very important.

Another skill area that receives a lot of attention in the literature reviewed is the lack of business knowledge on the part of IS personnel. No finding could be made concerning this skill as a requirement for programmers or systems analysts. This might be due to the fact that the perceptions of IS managers were measured, instead of the rest of the business personnel. IS managers might not perceive their staff as lacking business knowledge, while this perception might not be shared by the rest of the business personnel. For end-user support personnel, business knowledge as a skill is required at a proficient level. This is to be expected as end-user support personnel work more closely with the business personnel in the business areas.

Cheney, Hale and Kasper [4] also indicated that mainframe related knowledge would be less valuable in the future. This is supported by the finding that mainframe experience is significantly more required at a familiar level from systems analysts and end-user support personnel in contrast to the findings of Smith, Newton and Riley [15] who found that industry perceived a greater need for mainframe skills.

Zawacki *et al.* [19] indicated that more emphasis should be placed on the human side of IS in introductory IS courses to prevent students from choosing an IS career for the wrong reasons or simply for lack of knowledge of all skills required for an IS career. Hopefully this would help to lower the turnover rate of IS personnel who experience low job satisfaction. This study supports the findings of most of the other studies, stressing the importance of the human side of IS in undergraduate courses. However, this exposure is usually left for post-graduate courses in academic programs.

An interesting finding is that the mean of the requirements for systems analysts differs significantly from that of programmers and end-user support personnel. In general it seems that higher levels of ability are required from systems analysts than from the other two groups. Although businesses require the same mean level of ability from programmers and end-user support personnel, different skills are required.

A summary of the skills deemed important at each of the three levels for the different types of personnel, obtained from the results of the contingency analysis, is given below in Table 3.

Skills required of programmers are technically orientated and those required of end-user support personnel, business orientated. The generally low level of ability required of these two groups might indicate extensive inhouse training and a form of specialization in their particular work environments. The specific

	PROGRAMMERS	SYSTEM ANALYSTS	END-USER SUPPORT PERSONNEL
COMPETENCIES			
Business communication and interpersonal skills		▲	▲
Information systems planning		▲	○
Management skills	○	○	
Peopleware			▲
Systems approach		▲	
Legal aspects of computing	○	○	○
SKILLS			
Application programming languages (COBOL, PASCAL,...)	▲		○
System analysis and design		▲	○
Problem solving	▲	▲	▲
Data base concepts/ Data structures	▲	▲	
Operating Systems		○	
Business knowledge and skills (Accounting, Marketing)			▲
Documentation skills	▲	▲	
Fourth generation languages	▲		
Mainframe experience		○	○
Packages (Spreadsheet, Wordprocessing, Graphics)		■	▲
Telecommunication and networking	○	○	
System implementation		▲	
CASE methodologies		○	○
Modelling (Math, Statistics)	○	○	○
Decision Support Systems/ Executive Information Systems	○		▲
Expert Systems/ Artificial intelligence	○	○	○
Writing skills		▲	▲
Presentation techniques		▲	▲
CASE tools		○	○

Legend: ▲ - proficient ■ - knowledgeable ○ - familiar

Table 3

skills required at a proficient level from systems analysts, combined with the relatively high level of ability required in general from systems analysts, indicate a form of specialization regardless of the future work environments of this type of personnel.

It is quite interesting to note that businesses seem to agree to a considerable extent regarding the skills required of end-user support personnel, in comparison to the other two groups, as the most significant findings could be made for this group. When a skill was, for example, significantly more required at a proficient level, the same skill was generally significantly less required at a familiar level, indicating great conformity of opinion.

Considering the number of skills deemed important in this study at the proficient level, and those more important at the familiar level for the different job categories, it can be concluded that businesses have specific requirements of IS graduates, emphasising the need to consult businesses when developing IS curricula. Also, the skills required for the different job categories differ, underlining the fact that business has specific needs and requirements of each job category. These requirements are in line with expectations of the work definitions of the various job categories. Note that only one skill is required at the knowledgeable level. This re-enforces the above conclusion, as it is easier to choose the middle option of a given range (here: "knowledgable") if one does not have specific requirements. The results indicate that respondents either knew their exact requirements, or had at least given the matter some thought.

Internationally, the typical undergraduate IS curriculum demands four years of study. Judging from the list of skills deemed important for an IS graduate, four years of study would indeed seem unavoidable for tertiary institutions.

In the next section the implications of the abovementioned results for South African IS Departments are discussed.

6. Implications for South African academic IS departments

The study was undertaken with the explicit objective to obtain information about the skills required by businesses in South Africa from IS graduates. The first implication would therefore be that the results of this study should be considered when redesigning or rethinking IS curricula and should be an important input to any South African tertiary institution seriously engaged in the teaching of IS at the undergraduate level.

Secondly, it would not seem unreasonable to state that the majority of IS graduates in South Africa are lacking some knowledge which would integrate the various components of the IS curriculum better than could be done in a three year course, seeing that the fourth year of study is not mandatory and that very few students continue with graduate programs (where such integration is certainly possible). One way of addressing this shortcoming, would be to restructure the undergraduate program by extending the third year of study over two years. During the extended third year, students would be working part-time for pre-approved businesses. (This approach has already been implemented by some South African Technikons). Such a restructuring of the undergraduate program can only be undertaken if the IS Department has some form of alliance with businesses where practical work experience could form part of the third year of study.

The United Commissions Group [17] saw three reasons to form such an alliance:

* To keep abreast of technology trends
* To gain a better understanding of their business through research
* To help guide and shape information systems education to fit their future needs.

Another possible form of a partnership or alliance between an IS Department and businesses is to involve lecturers in business activities in order for them to stay in touch with current developments in the computer field as well as to gain practical experience of the requirements businesses have of their personnel. The correct curricula alone is of no use if the right people, people with practical experience, do not present the courses.

An interesting proposal was recently discussed [14] which entails that important aspects of business dynamics may be conveyed through simulations set in a business gaming environment. Simulation, it was suggested, could convey knowledge about the complex dynamic aspects of, for example, inter-organizational systems, while gaming could provide realism and stimulate interest among participants. Properly constructed business simulation games might indeed contribute considerably to provide students with experience in EDI, to develop an understanding for the value of information in a competitive market, and to gain hands-on experience in designing information systems around business protocols. Utilising a simulated business environment, a rich experience with realistic business requirements could be provided.

The suggestions above pertain to the possible restructuring of the IS curriculum. There is another implication for IS Departments: An IS Department cannot afford to have only periodic research contact with businesses. Constant interaction is necessary to stay attuned to the needs and expectations of the business world. An advisory committee comprising of representatives of various businesses might be a solution to this problem, though care should be taken not to address only the needs of the small group of businesses involved.

It must be kept in mind that a study such as this only represents the current situation and should not be taken as a long term indication. The future skills mix required of IS graduates would certainly evolve from what is expected of them today. The requirements for especially end-user support personnel might, however, change dramatically in the medium to long term, while the industry moves more towards end-user computing. This accentuates the need for continuous research as an extension of the present study. In designing an IS Curriculum, such long term shifts must be balanced against immediate requirements. However, precisely on this point academics very often shirk their responsibilities by simply declaring their curricula to be designed to prepare the student for a long work life, while in designing the curricula, no cognisance whatsoever was taken of business' needs.

7. Limitations of the study

The study only focused on the skills required for undergraduate courses, thus no recommendations could be made concerning post-graduate courses nor could any recommendations be made pertaining to the progression from undergraduate to post-graduate courses.

Not all industries are represented equally in the response, though questionnaires were sent to all industries with no deliberate discrimination against any industry sector. However, it is important to note that not all industries are necessarily equally strong or of equal size, where their IS environments are concerned. The ideal situation would be to obtain a response that reflects the real size of the IS environments in the various industries, if these figures were known and the necessary cooperation of all the industries could be ensured.

8. Areas for further research

The most obvious area for further research as an extension of the present study is the need to repeat this study, with the necessary changes, within five to ten years to determine changing needs. There is also a need for research to be done concerning the transition between undergraduate and graduate programs and the implications of a study such as this for the graduate program.

It was shown how the concept of double loop learning forms the basis for a fundamental approach to the re-design of IS curricula. The framework shown in Figure 1 could serve as a guideline for curriculum planning and improvement.

While this study has been undertaken to attempt to meet the qualitative demand for IS graduates better, an IS Department should also ensure that it keeps abreast of the quantitative requirements of industry in order to balance these two requirements appropriately.

11. Conclusion

An analysis was undertaken of the skills required by businesses in South Africa from entry-level programmers, systems analysts and end-user support personnel. Contrary to many other such studies, this study attempted to obtain more information than merely rankings of importance of various skills and competencies. From a curriculum design point of view, it is not very helpful merely to know that a particular skill or competency had been ranked higher than another. This does not tell one at what levels such skills and competencies must be taught. The end-result of curricula designed around ranked skills and competencies could very well be meaningless from businesses' point of view.

The results of our survey, especially those obtained from contingency analysis, brought important information to light for the design of South African IS curricula. Summarised, these are:

Application programming, problem solving, database concepts, documentation skills and fourth generation languages are required at a proficient level from programmers, while ***business communication and interpersonal skills, peopleware, problem solving, business knowledge, packages, decision support systems/ executive information systems, writing skills and presentation techniques*** are considered to be important at the proficient level for end-user support personnel.

The competencies ***business communication and interpersonal skills, information systems planning, systems approach*** and the skills ***systems analysis and design, problem solving, data base concepts, documentation skills, systems implementation, writing skills and presentation techniques*** are significantly more required at a proficient level rather than other competencies and skills for systems analysts.

It was also pointed out that, apart from a possible redesign of their curricula, academic IS Departments should reconsider their contact with the business world. Various alternatives were discussed which could enable IS Departments to infuse their curricula with more realism.

Bibliography

1. Albin, M & Otto, R.W. 1987. The CIS Curriculum: What Employers want from CIS and General Business Majors. *The Journal of Computer Information Systems.* Summer 1987:15-19.

2. Argyris, C. 1990. *Overcoming Organizational Defences: Facilitating Organizational Learning.* Allyn and Bacon, Boston.

3. Benbasat, I., Dexter, A.S. & Manatha, R.W. 1980. Impact of Organizational Maturity on Information System Skill Needs. *MIS Quarterly*, 4(1):21-34.

4. Cheney, P.H., Hale, D.P & Kasper, G.M. 1989. Information Systems Professionals: Skills for the 1990's. *Proceedings of the 22nd Annual Hawaii International Conference on Systems Sciences.* Honolulu, Hawaii, January:331-336.

5. Cheney, P.H. & Lyons, N.R. 1980. Information Systems Personnel Skill Requirement: A Survey. *MIS Quarterly*, 4(1):35-43.

6. Curriculum '95. 1994. IS '95: *The result of The Joint Task Force of ACM/AIS-ICIS/DPMA. Presented at ICIS '94.*

7. Froneman, L. 1995. Rethinking Information Systems Curricula for South Africa. *Unpublished honours dissertation, Department of Informatics, University of Pretoria.* January 1995.

8. Froneman, L & Roode, J.D. 1995a. *A Generic Framework for the improvement of IS Curricula. Submitted for ICIS 95.*

9. Froneman, L & Roode, J.D. 1995b. An analysis of IS'95. *Working paper, Department of Informatics, University of Pretoria.* April 1995.

10. Goldsworthy, A.W. 1993. IT and the Competency debate - Skill vs Knowledge - A Major Issue. *The Australian Computer Journal*, 25(3):113-123.

11. ISCR (Information Systems Curriculum Recommendations) for the 80s: Undergraduate and Graduate Programs. *Communications of the ACM*, 25(11):781-788. Edited by Nunamaker, J.F., Couger, J.D. & Davis, G.B.

12. Jenkins, G.H. 1986. Education Requirements for the Entry Level Business Systems Analyst. *Journal of Systems Management*, August 1986:30-34.

13. McCubbrey, D *et al.* 1994. Interorganizational business simulation and gaming: Rethinking Information Systems Curricula. *Proceedings of the fifteenth International Conference on Information Systems.* December 1994. Vancouver, British Columbia, Canada.

14. Nelson, R. *et al.* 1991. Education needs as Perceived by IS and End-user Personnel: A Survey of Knowledge and Skill Requirements. *MIS Quarterly*, December:505-525.

15. Smith, D.C., Newton, S. & Riley M.J. 1992. An Evaluation of the Skill Requirements of Entry-level Graduates in the Information Systems Industry. *South African Computer Journal*, 8:52-55.

16. Steyn, A.G.W.; Smit, C.F. & du Toit, S.H.C. 1989. *Moderne Statistiek vir die Praktyk.* J.L. van Schaik (Edms) Bpk, Pretoria.

17. United Commissions Group, 1989. Business and Education: Forming new Partnerships. *I/S Analyzer*, 27(4):1-16.

18. Watson, H.J. *et al.* 1990. Requisite Skills for new MIS hires. *Data Base*, 21(1):20-29.

19. Zawacki, R.A. *et al.* 1988. How college students Choose IS Careers. *Datamation*, September 15:43-48.

Appendix

VARIABLE	TOTAL	MEAN	STANDARD DEVIATION
Personnel in IS division	9148	125.32	190.34
Graduates employed per year	311	4.26	10.23

Table A1 - General statistics for the entire study

INDUSTRY	VARIABLE	TOTAL	MEAN	STANDARD DEVIATION
AGRICULTURE	P	126	25.2	6.42
	G	5	1	1.42
BROADCASTING	P	121	121	.
	G	0	0	.
COMMUNICATION	P	230	230	.
	G	10	10	.
CONSULTING	P	536	178.67	159.94

	G	85	28.3	44.77
ELECTRONICS	P	5	5	.
	G	0	0	.
ENERGY	P	750	375	106.07
	G	25	12.5	10.61
ENGINEERING	P	18	18	.
	G	0	0	.
FINANCIAL	P	1445	206.43	231.57
	G	21	3	3.65
FOOD	P	40	20	9.89
	G	0	0	0
GOVERNMENT	P	583	83.29	101.62
	G	15	2.14	3.58
INSURANCE	P	1987	397.4	444.17
	G	41	8.2	6.94
MANUFACTURING	P	347	28.92	18.71
	G	10	0.83	1.27
MINING	P	609	87	109.55
	G	21	3	3.42
MINING & FINANCIAL	P	70	70	.
	G	0	0	.
MINING & MANUFACTURING	P	320	320	.
	G	20	20	.
PUBLISHING	P	120	120	.
	G	4	4	.
RESEARCH	P	345	115	137.22
	G	6	2	1.73
RETAIL	P	170	170	.
	G	6	6	.
SERVICE	P	1326	110.5	195.53
	G	42	3.5	5.58
G - Graduates employed per year P - Personnel in IS division				

Table A2 - General statistics by industry

GEOGRAPHICAL LOCATION	VARIABLE	TOTAL	MEAN	STANDARD DEVIATION
BEDFORDVIEW	P	120	60	56.57
	G	8	4	4.24
BETHAL	P	24	24	.
	G	0	0	.
BOKSBURG	P	10	10	.
	G	0	0	.
BRAAMFONTEIN	P	5	5	.
	G	0	0	.
CAPE TOWN	P	1926	275.14	383.85
	G	110	15.71	29.19
DURBAN	P	126	25.2	11.3
	G	5	1	1
ELANDSFONTEIN	P	18	18	.
	G	0	0	.
HENNOPSMEER	P	60	60	.
	G	2	2	.
ISANDO	P	38	9.5	6.76
	G	0	0	0
JOHANNESBURG	P	2855	158.61	183.72
	G	50	2.78	2.73
KIMBERLEY	P	14	14	.
	G	0	0	.
KLERKSDORP	P	25	25	.
	G	0	0	.
MIDDELBURG	P	53	53	.
	G	4	4	.
MIDRAND	P	132	44	3.46
	G	5	1.67	1.53
ORANJEMUND	P	43	43	.
	G	2	2	.
PHALABORWA	P	20	20	.
	G	0	0	.
PORT ELIZABETH	P	30	30	.

	G	1	1	.
PRETORIA	P	2183	181.92	203.05
	G	80	6.67	7.36
RICHARDSBAAI	P	13	13	.
	G	0	0	.
SANDTON	P	510	255	275.77
	G	22	11	12.73
SASOLBURG	P	300	300	.
	G	5	5	.
STELLENBOSCH	P	25	25	.
	G	3	3	.
SWAKOPMUND	P	12	12	.
	G	0	0	.
VERWOERDBURG	P	156	78	101.82
	G	1	0.5	0.71
VREDEDORP	P	90	90	.
	G	4	4	.
WELKOM	P	320	320	.
	G	8	8	.
WITBANK	P	40	40	.
	G	1	1	.
G - Graduates employed per year P - Personnel in IS division				

Table A3 - General statistics by region

RESPONDENTS BY INDUSTRY TYPE			
Industry	**Frequency**	**Percent**	**Cumulative Percent**
Agriculture	5	6.8	6.8
Broadcasting	1	1.4	8.2
Communication	1	1.4	9.6
Consulting	3	4.1	13.7
Electronics	1	1.4	15.1
Energy	2	2.7	17.8
Engineering	1	1.4	19.2
Financial	7	9.6	28.8
Food	2	2.7	31.5
Government	7	9.6	41.1
Insurance	5	6.8	47.9
Manufacturing	12	16.4	64.4
Mining	7	9.6	74.0
Mining & Financial	1	1.4	75.3
Mining & Manufacturing	1	1.4	76.7
Publishing	1	1.4	78.1
Research	3	4.1	82.2
Retail	1	1.4	83.6
Service	12	16.4	100.0

Table A4

RESPONDENTS BY GEOGRAPHICAL LOCATION

Location	Frequency	Percent	Cumulative Percent
Bedfordview	2	2.7	2.7
Bethal	1	1.4	4.1
Boksburg	1	1.4	5.5
Braamfontein	1	1.4	6.8
Cape Town	7	9.6	16.4
Durban	5	6.8	23.3
Elandsfontein	1	1.4	24.7
Hennopsmeer	1	1.4	26.0
Isando	4	5.5	31.5
Johannesburg	18	24.7	56.2
Kimberley	1	1.4	57.5
Klerksdorp	1	1.4	58.9
Middelburg	1	1.4	60.3
Midrand	3	4.1	64.4
Oranjemund (Namibia)	1	1.4	65.8
Phalaborwa	1	1.4	67.1
Port Elizabeth	1	1.4	68.5
Pretoria	12	16.4	84.9
Richardsbaai	1	1.4	86.3
Sandton	2	2.7	89.0
Sasolburg	1	1.4	90.4
Stellenbosch	1	1.4	91.8
Swakopmund	1	1.4	93.2
Verwoerdburg	2	52.7	95.9
Vrededorp	1	1.4	97.3
Welkom	1	1.4	98.6
Witbank	1	1.4	100.0

Table A5

RESPONDENTS BY SIZE OF IT/MIS DIVISION			
Number of employees	**Frequency**	**Percent**	**Cumulative Percent**
0 - 50	42	57.5	57.5
51 - 100	9	12.4	69.9
101 - 200	8	10.9	80.8
201 - 300	3	4.1	84.9
301- 400	6	8.3	93.2
401 - 500	1	1.4	94.5
501 - 600	1	1.4	95.9
601 - 700	1	1.4	97.3
701- 800	1	1.4	98.6
> 1000	1	1.4	100.0

Table A6

NUMBER OF GRADUATES EMPLOYED PER YEAR			
Graduate employees	**Frequency**	**Percent**	**Cumulative Percent**
0	27	37.0	37.0
1	11	15.1	52.1
2	8	11.0	63.0
3	3	4.1	67.1
4	7	9.6	76.7
5	3	4.1	80.8
6	2	2.7	83.6
7	2	2.7	86.3
8	2	2.7	89.0
10	3	4.1	93.2
20	4	5.5	98.6
80	1	1.4	100.0

Table A7

RESPONDENTS' PERCEPTION OF GRADUATES NEEDING FURTHER TRAINING			
	Frequency	**Percent**	**Cumulative Percent**
Yes	68	93.2	93.2
No	5	6.8	100.0

Table A8

A one-way analysis of variance was used to analyze the data as they pertain to the research hypotheses, statistically stated as follows:

H0: $\mu_1 = \mu_2 = \mu_3$ (The type of personnel has no effect on the requirements of businesses).

H1: not all are equal (The type of personnel does have an effect on the requirements of businesses).

Using $\alpha = 0.05$, H1 is accepted if the probability, given by probability = $P(F \leq S^2_1/S^2_2)$ is less than α (refer to table A9). Since $p = 0.0001$, and $p < 0.05$, the null hypothesis is rejected at a 5% level of significance. Thus the type of personnel does have an effect on the requirements of businesses.

SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F VALUE
MODEL	4.3136	2	2.1568	13.05
ERROR	12.3913	75	0.1652	
TOTAL	16.705	77		

Table A9 - Analysis of variance

Multiple comparisons were performed using Scheffé's test to determine where the difference(s) lies. Scheffé's procedure of comparison in pairs of means of a completely random experiment, is based on the collection of confidence intervals for $\mu_i - \mu_j$, $i < j$. The combined confidence coefficient for these intervals is 0.95 and thus the means differ significantly if $\mu_i - \mu_j$ includes a zero. The results of this test show that the mean of the requirements for systems analysts differs significantly from the means for programmers and end-user support personnel. This seems to imply that businesses require the same level of skills from programmers and end-user support personnel and seems to be counter-intuitive. In fact the results of the contingency analysis show that this is not so - businesses in general, while typically requiring the same level of skill from programmers and end-user support personnel, require the different skills at different levels.